Check List 9(2): 400–404, 2013
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ISSN 1809-127X (available at *www.checklist.org.br*)

Check List
Journal of species lists and distribution

LISTS OF SPECIES

Anurans of Bhitarkanika mangroves, Odisha, east coast of India

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ABSTRACT: Anurans of Bhitarkanika National Park, the second largest viable mangrove ecosystem measuring 141.44 km^2 on the east coast of India, are understudied. This paper presents a comprehensive list of anuran species encountered in and around the protected area. Visual Encounter Surveys during the rainy and winter season in four sites yielded a total of 14 species belonging to five families. Of these, eight species were new records from Bhitarkanika National Park, belonging to the families Bufonidae (*Duttaphrynus stomaticus*), Dicroglossidae (*Euphlyctis hexadactylus*, *Fejervarya cancrivora*, *Fejervarya syhadrensis*, *Hoplobatrachus crassus*, *Sphaerotheca rolandae*), Microhylidae (*Microhyla ornata*) and Ranidae (*Hylarana tytleri*). Sightings of *Sphaerotheca rolandae*, *Hylarana tytleri* and *Duttaphrynus stomaticus* were very few in number. All other species found were well represented throughout the study area. Scope for future suggested studies is emphasized.

INTRODUCTION

Amphibians play a very important role in the food chain of both terrestrial and aquatic ecosystems. The general ecological importance of amphibians lies in them being predators acting as primary and secondary carnivores on insects, some of which are crop pests or disease vectors (Behangana 2004). Amphibians are widely considered to be useful as indicator species (Welsh and Ollivier 1998, Sheridan and Olson 2003). Amphibian diversity in mangroves is comparatively low and limited to freshwater species intruding the area (Alfred and Ramakrishna 2004). Amphibians in India are highly diverse with 342 species of which 305 are anurans (Dinesh *et al.* 2012; Anil *et al.* 2011; Biju *et al.* 2011). Most of the studies on amphibians have been concentrated in the Western Ghats (biodiversity hotspot), on the west coast of India, and other areas remain understudied (Aravind and Gururaja 2011). Of the 26 species of frogs found in Odisha, only five species, belonging to three genera and three families have been reported from Bhitarkanika. These include the families Bufonidae (1 species), Rhacophoridae (1 species) and Ranidae (3 species) (Chadha and Kar 1999). Dutta (2007) reported 14 species of amphibian fauna from Dhamra Port site in the district of Bhadrak in Odisha. *Kaloula taprobanica* was reported from a tree hole in a mangrove swamp at Bhitarkanika, Odisha (Sengupta *et al.* 2009). Dutta *et al.* (2009) reported 21 species of anurans from Similipal Biosphere Reserve including representatives from the families Bufonidae (three species), Dicroglossidae (eight species), Microhylidae (five species), Ranidae (one species) and Rhacophoridae (four species).

The present work was undertaken to study the diversity and distribution of amphibians in mangrove ecosystem of Bhitarkanika National Park. In this study, we present a comprehensive list of anuran species found and their distribution in and around the wetlands of Bhitarkanika.

MATERIALS AND METHODS

Study area

Bhitarkanika National Park, in the lower reaches of the Dhamra-Patsala-Maipura River, is an important patch of mangrove along the east coast of India (Figure 1). It is a micro-environmental region of Rajnagar Block in Kendrapada district of Odisha, extending over an area of 141.44 km^2 and is located between 20°4'00" N -20°8'00" N and 86°45'00" E - 87°50'00" E. The estuaries, at the mouth of the river Brahmani, Baitarani, Dhamra, and a large number of ramifying creeks, channels, and distributaries receive tidal water twice a day. The land elevation ranges from 3.66 m to 8.23 m. This area receives annual rainfall of 1683.4 mm of which 80% falls from June to September due to the south-east monsoon. In summer, the temperature ranges from 27.1°C to 40.7°C (min. and max. respectively),

FIGURE 1. Map showing location of Bhitarkanika National Park, Odisha, India. 1. Unprotected Area, Dangmal; 2. Protected Area, Dangmal; 3. Bagagahan and 4. Kalibhanjadia Protected Area.

whereas during winter it is 12.6°C to 26.1°C. The relative humidity remains between 75 - 85% throughout the year. The study area covers: 1. parts of Dangmal (unprotected area), 2. parts of Dangmal (protected area), 3. Bagagahan, and 4. Kalibhanjadia (protected area).

The study area (Dangmal) was classified into two land use types: (i) an unprotected residential area and its adjacent farmland area and (ii) the protected or reserve area. Each land use type was further sub-divided into three regions i.e. DL - dry land (elevated dry terrain), CR-creeks, which consists of a swampy saline creek, and WB-water bodies (temporary and permanent ponds). The study area in Bagagahan and Kalibhanjadia are islands, free of human interference, and crisscrossed by numerous creeks and crick lets.

Amphibian sampling

The study was undertaken from October, 2009 to January, 2011 (15 months). Visual Encounter Surveys (VES), as defined by Crump and Scott (1994), was the detection technique used in all the sites and their boundaries to sample anuran species on the leaf litter, vegetation, pasture, creeks, and ponds (temporary and permanent) and all species sighted were recorded. Systematic stratified random sampling, night survey with torch lights (17:30 h - 23:30 h), seasonal search in all microhabitats, and opportunistic observations were included to verify overall diversity in the region from June, 2010 to January, 2011 (six months). This site being a protected area, no specimens were collected but each species was photographed with a digital camera for reference, identified directly in the field and then released. The species were identified based on the photographs, using keys and original publications (Boulenger 1890, 1920; Ahl 1931; Vasudevan *et al.* 2001 and Daniel 2002).

Results and Discussion

A total of 824 individual anurans, representing 14 species and five families, were registered during the study period (Table 1-2; see pictures of some species in Figure 2). The number of anuran species found in the area represented 42% of species already known to occur (Chadha and Kar 1999; Sengupta *et al.* 2009). Of the five families, Dicroglossidae had the maximum number of species (eight), followed by Bufonidae (two), Microhylidae (two), Rhacophoridae (one) and Ranidae (one). An important aspect of the study is that eight new species were recorded for Bhitarkanika NP, including *Duttaphrynus stomaticus* (Bufonidae), *Euphlyctis hexadactylus, Fejervarya cancrivora, Fejervarya syhadrensis, Hoplobatrachus crassus* and *Sphaerotheca rolandae* (Dicroglossidae); *Microhyla ornata* (Microhylidae) and *Hylarana tytleri* (Ranidae).

In the study area, out of 14 species, 13 were recorded from the protected area of Bhitarkanika (Dangmal). The paddy field frog *Fejervarya orissaensis* was found in all the habitats studied (Table 1). The crab-eating frog (*Fejervarya cancrivora)* was recorded from saline creeks throughout the study area, with a maximum number of individuals at Kalibhanjadia (83%). *Euphlyctis hexadactylus* was abundantly found in freshwater ponds with dense vegetation. *Kaloula taprobanica* was recorded only from the dry land area (DL) inside the Dangmal, mostly

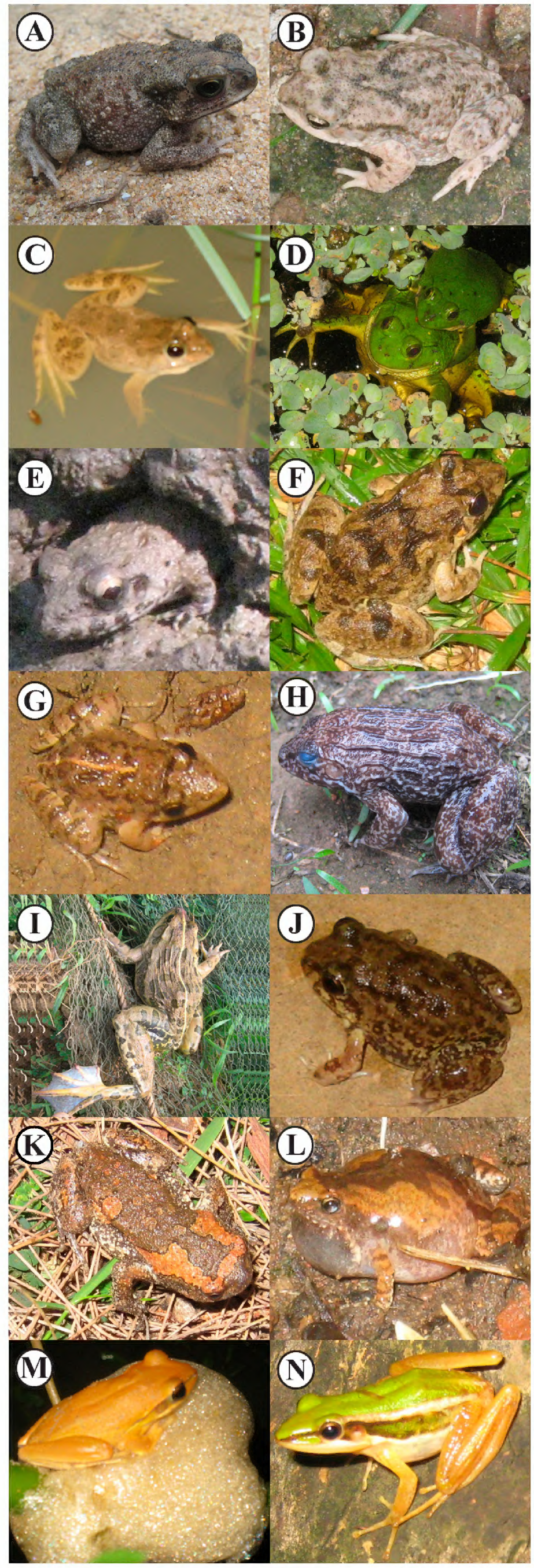

Figure 2. Anurans of Bhitarkanika National Park, Odisha, India. A) *Duttaphrynus melanostictus*; B) *Duttaphrynus stomaticus*; C) *Euphlyctis cyanophlyctis*; D) *Euphlyctis hexadactylus*; E) *Fejervarya cancrivora*; F) *Fejervarya orissaensis*; G) *Fejervarya syhadrensis*; H) *Hoplobatrachus crassus*; I) *Hoplobatrachus tigerinus*; J) *Sphaerotheca rolandae*; K) *Kaloula taprobanica*; L) *Microhyla ornata*; M) *Polypedates maculatus*; N) *Hylarana tytleri*.

from grooves and tree trunks. *Sphaerotheca rolandae, Hoplobatrachus crassus* and *Duttaphrynus stomaticus* were rare, recorded only once each in the reserve area in Dangmal. All other species were found throughout the study area in high number.

The number of *D. melanostictus* (Bufonidae) in the present study was maximum, but its distribution was restricted mostly to residential areas inside Bhitarkanika. Other anurans found in the present study with higher number were *Fejervarya cancrivora, Euphlyctis hexadactylus, Fejervarya orissaensis* and *Euphlyctis cyanophlyctis,* all in the family Dicroglossidae (Table 2).

The protected area of Bhitarkanika (Dangmal) has a high anuran diversity (13 species), followed by the unprotected area (12 species), Kalibhanjadia (6 species) and Bagagahan (4 species).

During winter and summer (November to May), Bhitarkanika receives sporadic rainfall and remains very wet with heavy rainfall from June to September. Amphibians which were abundant during the rainy season were more scarce during the dry period just after winter. This may be due to the predatory activity of the migratory avian population in the study area.

Table 1. Anuran species from different localities of Bhitarkanika National Park, Odisha, east coast of India. + indicates presence; - indicates absence; DL: Dry land; WB: Water bodies and CR: Creeks; UN-P (BK): Unprotected area in Bhitarkanika; P-BK: Protected area in Bhitarkanika; BG: Bagagahan and KBD: Kalibhanjadia.

TAXA	UN-P (BK)			P (BK)			BG	KBD
	DL	WB	CR	DL	WB	CR		
BUFONIDAE (Gray)								
1. Duttaphrynus melanostictus (Schneider, 1799)	+	-	-	+	-	-	-	-
2. D. stomaticus (Lutken, 1862)	-	-	-	+	-	-	-	-
DICROGLOSSIDAE (Anderson)								
3. Euphlyctis cyanophlyctis (Schneider, 1799)	+	+	-	-	+	-	-	+
4. E. hexadactylus (Lesson, 1834)	-	+	-	-	+	-	+	-
5. Fejervarya cancrivora (Gravenhorst, 1829)	+	-	+	+	-	+	+	+
6. F. orissaensis (Dutta, 1997)	+	+	+	+	+	+	+	+
7. F. syhadrensis (Annandale, 1919)	+	+	-	+	+	-	-	-
8. Hoplobatrachus crassus (Jerdon, 1854)	-	+	-	+	-	-	-	+
9. H. tigerinus (Daudin, 1802)	-	+	-	-	+	-	-	+
10. Sphaerotheca rolandae (Dubois, 1983)	-	-	-	+	-	-	-	-
MICROHYLIDAE (Gunther)								
11. Kaloula taprobanica (Parker, 1934)	+	-	-	+	-	-	-	-
12. Microhyla ornata (Duméril and Bibron, 1841)	+	-	-	+	-	-	-	-
RHACOPHORIDAE (Hoffman)								
13. Polypedates maculatus (Gray, 1834)	+	-	+	+	-	+	+	+
RANIDAE (Rafinesque)								
14. Hylarana tytleri (Theobald, 1868)	+		-	-	-	-	-	-

Table 2. Checklist and distribution of anurans from Bhitarkanika National Park; UN-P (BK): Unprotected area in Bhitarkanika; P-BK: Protected area in Bhitarkanika; BG: Bagagahan and KBD: Kalibhanjadia.

TAXA	UNP (BK)	P (BK)	BG	KBD	TOTAL
BUFONIDAE (Gray)					
1. Duttaphrynus melanostictus (Schneider, 1799)	78	111	-	-	189
2. D. stomaticus (Lutken, 1862)	-	2	-	-	2
DICROGLOSSIDAE (Anderson)					
1. Euphlyctis cyanophlyctis (Schneider, 1799)	37	32	-	14	83
2. E. hexadactylus (Lesson, 1834)	61	92	2	-	155
3. Fejervarya cancrivora (Gravenhorst, 1829)	15	21	11	123	170
4. F. orissaensis (Dutta, 1997)	36	50	13	7	106
5. F. syhadrensis (Annandale, 1919)	7	22	-	-	29
6. Hoplobatrachus crassus (Jerdon, 1854)	2	2	-	4	8
7. H. tigerinus (Daudin, 1802)	9	3	-	3	15
8. Sphaerotheca rolandae (Dubois, 1983)	-	4	-	-	4
MICROHYLIDAE (Gunther)					
1. Kaloula taprobanica (Parker, 1934)	8	7	-	-	15
2. Microhyla ornata (Duméril and Bibron, 1841)	9	4	-	-	13
RHACOPHORIDAE (Hoffman)					
1. Polypedates maculatus (Gray, 1834)	19	11	2	1	23
RANIDAE (Rafinesque)					
1. Hylarana tytleri (Theobald, 1868)	2	-	-	-	2
Total	**283**	**361**	**28**	**152**	**824**
Total Species	**12**	**13**	**4**	**6**	

Globally, little is known of the amphibian fauna inhabiting mangroves (Kathiresan and Bingham 2001). Amphibians are generally intolerant of saline conditions found within mangroves, although many species are associated with estuarine habitats (Hedges and Thomas 1992). Kathiresan and Rajendran (2004) reported occurrence of 13 species of amphibians from Indian mangroves. One species of frog was reported in the Vellar Estuary mangroves and five species of amphibians from Hooghly Estuary (Rao 2004). Dev Roy and Sivaperuman (2012) reported 11 species of amphibians alone from Sundarban mangrove ecosystem in India. Satheeshkumar (2011) first recorded the mangrove frog *Frejervarya cancrivora* from Pondichery mangroves, India. The above literature indicates that the amphibian diversity of mangrove environments is understudied. Our study forms the first report of this type, registering 14 species of anuran amphibians in the Bhitarkanika mangroves, Odisha, including new records for eight species.

Conclusion

Wildlife inventories form the foundation for selecting priority sites for conservation and to identify priority species (Daily *et al.* 2003) and the relevance has become even more paramount because of the alarming rate of species extinction (Santos-Barrera *et al.* 2008). More than 40% of a sample of amphibians, reptiles, mammals, and birds that are restricted to mangrove ecosystems are globally threatened with extinction (Luther and Greenberg 2009).

Amphibians hold vital positions in forest and aquatic food webs; they are also important for the nutrient portion of the vertebrate biomass (Hutchens and De Perno 2009). Their conspicuous role is noted to be of particular importance in tropical forests, where in acting as both predator and prey species, they play a key role in trophic dynamics (Toft 1980; Blaustein *et al.* 1994). Their high collective biomass, alongside their high digestion and production efficiencies (Woolbright 1991), go some way to explaining their potential importance in such "functions" as the maintenance of ecosystem energetics and carbon flow (Pearman 1997) -namely through the maintenance of arthropod abundance (Guyer 1990), and the provision of a critical prey base for higher order predators, such as arachnids, snakes, and birds (Guyer 1990; Woolbright 1991; Duellman and Trueb 1994).

The number of species revealed by this study seems low and there is an urgent need to carry out further studies for confirmation regarding diversity, distribution and status of amphibians, and implementation of effective strategy for their conservation if needed. Additional research is needed worldwide to better understand mangrove-endemic vertebrates, particularly amphibians, for conservation purposes.

Acknowledgments: We are thankful to the PCCF, Wildlife-cum-Chief Wildlife Warden, Odisha, Bhubaneswar for granting permission to work in the protected area. We thank Dr. Kaushik Deuti, Amphibian Section, Zoological Survey of India, Kolkata for helping with identification of some species. We are also thankful to Dr. S.K. Kar and Dr. C.S.K. Kar, Office of the PCCF, Wildlife and Chief Wildlife Warden, Bhubaneswar for their valuable suggestions.

Literature Cited

Ahl, E. 1931. Anura III, Polypedatidae, *Das Tierreich*. Berlin and Leipzig: Walter de Guyter. xiv+477 p.

Alfred, J.R.B. and Ramakrishna. 2004. Faunal Resources in Mangrove Ecosystem. *Envis Forestry Bulletin* 4: 24-31.

Anil, Z., K.P. Dinesh, E. Kunhikrishnan, S. Das, V.R. Raju, C. Radhakrishnan, M.J. Palot, and S. Kalesh. 2011. Nine new species of frogs of the genus *Raorchestes* (Amphibia: Anura: Rhacophoridae) from southern Western Ghats, India. *Biosystematica* 5: 21-48.

Aravind, N.A. and K.V. Gururaja. 2011. *Theme paper on the amphibians of the Western Ghats. Report submitted to Western Ghats ecology panel. MoEF*. Electronic database accessible at http://www.westernghatsindia.org/sites/default/files/Amphibians%20of%20Western%20Ghats.pdf. Captured on 28 December 2011.

Behangana, M. 2004. The diversity and status of amphibians and reptiles in the Kyoga Lake Basin. *African Journal Ecology* 42: 51-56.

Biju, S.D., I.V. Bocxlaer, S. Mahony, K.P. Dinesh, C. Radhakrishnan, A. Zachariah, V. Giri, and F. Bossuyt. 2011. A taxonomic review of the Night Frog genus *Nyctibatrachus* Boulenger, 1882 in the Western Ghats, India (Anura: Nyctibatrachidae) with description of twelve new species. *Zootaxa* 3029: 1-96.

Blaustein, A. R., D. B. Wake and W. Sousa. 1994. Amphibian declines: judging the stability, persistence, and susceptibility of local populations to local and global extinction. *Conservation Biology* 8: 60–71.

Boulenger, G.A. 1890. The Fauna of British India, including Ceylon and Burma, Reptilia and Batrachia. Taylor and Francis. xviii+541 pp.

Boulenger, G.A. 1920. A monograph of the South Asian, Papuan, Melanesian and Australian frogs from the genus *Rana*. *Records of the Indian Museum, Calcutta*: 1-226.

Chadha, S. and C.S. Kar. 1999. *Bhitarkanika: Myth and Reality*. New Delhi: Nat Raj Publishers. 388p.

Crump, M.L., and N.J. Jr., Scott. 1994. Visual encounter surveys; p. 84-92 *In* W.R. Heyer, M.A. Donnelly, R.W. Mcdiarmid, Hayek. and M.S. Foster (ed). *Measuring and monitoring biological Diversity: standard methods for amphibians* Smithsonian Institution Press, Washington DC.

Daily, G.C., G. Ceballos, J. Pacheco, G. Suzán and A. Sánchez-Azofeifa. 2003. Countryside Biogeography of Neotropical Mammals: Conservation Opportunities in Agricultural landscape of Costa Rica. *Conservation Biology* 17: 1-11.

Daniel, J.C. 2002. Amphibians and Reptiles of India. Mumbai: The Bombay Natural History Society and Oxford University Press. 238 p.

Dev Roy, M.K. and C. Sivaperuman. 2012. Fauna of Ecosystems of India-Mangroves. *Zoological Society of India*: 1-11.

Dinesh, K.P., C. Radhakrishnan, K.V. Gururaja, K. Deuti and G.K. Bhatt. 2012. *A Checklist of Amphibia of India with IUCN Red list Status.* Zoological Survey of India. Electronic database accessible at http://zsi.gov.in/checklist/Amphibia_final.pdf. Captured on 24 February 2013.

Duellman, W. E. and L. Trueb. 1994. Biology of amphibians. John Hopkins University Press.

Dutta, S. 2007. Biodiversity assessment of Dhamra port site and surrounding areas, Orissa. Bangalore: Greenpeace India. 38p.

Dutta, S.K., M.V. Nair, P.P. Mohapatra and A.K. Mohapatra. 2009. *Amphibians and Reptiles of Similipal Biosphere Reserve*. Bhubaneswar: Plant Resource Centre. 172 p.

Guyer, C. 1990. The herpetofauna of La Selva, Costa Rica. In: Four neotropical rainforests: 371–385 *In* A. H. Gentry (ed.). Yale University Press, New Haven.

Hedges, S.B. and R. Thomas. 1992. A new marsh-dwelling species of *Eleutherodactylus* from Haiti (Anura: Leptodactylidae). *Journal of Herpetology* 26: 191-195.

Hutchens, S. and C. DePerno. 2009. Measuring species diversity to determine land-use effects on reptile and amphibian assemblages. *Amphibia-Reptilia* 30: 81-88.

Kathiresan, K. and B.L. Bingham. 2001. Biology of mangroves and mangrove ecosystems. *Advances in Marine Biology* 40: 81-251.

Kathiresan, K. and N. Rajendran. 2004. Mangrove ecosystem of Indian Ocean region. *Indian Journal of Marine Sciences* 34(1): 104-113.

Luther, D.A. and R. Greenberg. 2009. Mangroves: A global perspective on the evolution and conservation of their terrestrial vertebrates. *BioScience* 59(7): 602-612.

Parker, H.W. 1934. A Monograph of the Frogs of the Family Microhylidae, British Museum, London. vii+208 pp.

Pearman, P. B. 1997. Correlates of amphibian diversity in an altered landscape of Amazonian Ecuador. *Conservation Biology* 11: 1211–1225.

Rao, C.A.N. 2004. Faunal Diversity: Estuarine Ecosystem. *Environment Protection Training Research Institute-Environmental Information System (EPTRI-ENVIS) Newsletter* (3): 8-11.

Santos-Barrera, G., J. Pacheco, F. Mendoza-Quijano, F. Bolaños, G. Cháves, G.C. Daily, P.R. Errlich and G. Ceballos. 2008. Diversity, natural history and conservation of amphibians and reptiles from the San Vito region, south-western Costa Rica. *Revista de Biologia Tropical* 56(2): 755-778.

Satheeshkumar, P. 2011. First record of mangrove frog *Fejervarya cancrivora* (Amphibia: Ranidae) in the Pondichery mangroves. *World Journal of Zoology* 6 (3): 328-330.

Sengupta, S., A. Das, S. Das, B. Hussain, N. K. Choudhury and S. K.Dutta. 2009. Taxonomy and Biogeography of *Kaloula* Species of Eastern India. *The Natural History Journal of Chulalongkorn University* 9(2): 209-222.

Sheridan, C.D. and D.H. Olson. 2003. Amphibian assemblages in zero-order basins in the Oregon Coast Range. *Canadian Journal of Forest Research* 33:1452-1477.

Toft, C. A. 1980. Resource partitioning in amphibians and reptiles. *Copeia*: 121.

Vasudevan, K., Ajith Kumar and Ravi Chelam. 2001. Structure and composition of rainforest floor amphibian communities in Kalakad-Mundanthurai Tiger Reserve. *Current Science* 80 (3): 406-412.

Welsh, H. H. J. and L. M. Ollivier. 1998. Stream amphibians as indicators of ecosystem stress: A case study from California's redwoods. *Ecological Applications* 8: 1118-1132.

Woolbright, L. L. 1991. The impact of hurricane Hugo on forest frogs in Puerto Rico. *Biotropica* 23: 462–467.

Received: December 2012
Accepted: March 2013
Published online: April 2013
Editorial responsibility: Olivier S. G. Pauwels